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(54) **Electronic camera having a printer for providing improved hard copy images**

(57) In an electronic camera is disclosed in which an image of a subject is focused on an area image sensor. The image is stored in a memory which drives a display. After a user views the display, the user can adjust

the image parameters to provide an improved image. A printer makes optical hard copy of the improved image directly off the display.

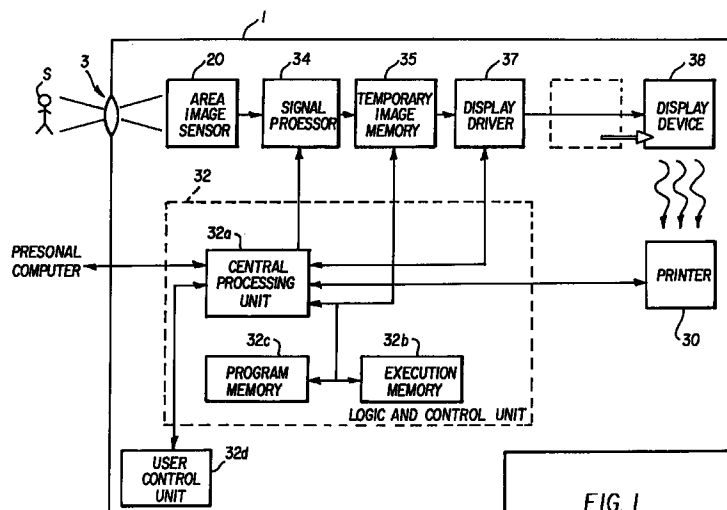


FIG. 1

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Description

The present invention relates to electronic cameras and, more particularly, to an electronic camera which produces a visual display and a hard copy of such visual display.

It is known in the prior art to provide a electronic camera which uses an area image sensor. Digital images produced from the image sensor are stored in memory and these images can be shown on a display so that the user can determine which image should be stored for use in producing hard copy images. Typically, these images can be stored in a magnetic disk or a compact PCMCIA Flash RAM Card.

In US-A-4,262,301 an electronic camera is disclosed which includes a display device. The camera also includes a digital-to-analog converter which sends signals to the display. Also, the digital-to-analog converter selectively sends these images to a magnetic tape for storage. Images on the magnetic tape can then be produced as a hard copy by a printer which is provided on the camera. A problem with the approach in US-A-4,262,301 is approach is that a print must be made in order for a user to determine whether it is satisfactory.

A shortcoming with prior electronic cameras is that the printer is spaced from the camera and must be electrically coupled to digital storage structure within the camera which fluently produces artifacts. Printers often use a structure which provide relative movement of a head and a media sheet which induces artifacts into the output hard copy print and is therefore difficult to provide an effective structure mounted on a camera body.

With any of these camera systems, a print is made and then a user views the print to decide whether it is acceptable. Oftentimes, a print is unacceptable and another print must be made.

It is an object of the present invention to provide an electronic camera with a printer which can effectively provide an improved hard copy print

This object is achieved by an electronic camera, the improvement comprising:

- a) means for focusing an image of a subject at a image plane;
- b) area image sensor means disposed at the image plane for receiving the image subject and producing a digital image representing the subject;
- c) storage means coupled to the area image sensor for storing the digital image of the subject;
- d) display means responsive to the digital image for displaying an image of the subject;
- f) image adjustment means initiated by a user after viewing the displayed image for varying parameters of the digital image to provide an improved digital image which is displayed by the display means;
- g) printer means being effective, in an operative condition, to be optically coupled to the display

means for producing a hard copy of the improved subject display image produced by the display means; and

h) logic and control means for selectively focusing an image of a subject on the area image sensor and for selectively causing the printer means to be effective in its operative position to make a hard copy representation of the displayed subject.

It is an advantage of the present invention that improved hard copies can be made directly from an image display which is entirely satisfactory to a user.

FIG. 1 is a block diagram of a digital camera in accordance with the present invention with the necessary electronics for operating the camera;

FIG. 2 is a back view of a digital camera showing its image display in a user viewable position and having an optical printer;

FIG. 3 is a bottom view of the camera shown in FIG. 2;

FIG. 4 is a back view of the digital camera of FIG. 2 showing its image display in a storage position ready for printing;

FIG. 5 is a side sectional view taken along the lines A-A of FIG. 2

FIG. 6 is a bottom view similar to FIG. 2 but showing a photosensitive sheet in the process of being driven by a set of processing rollers;

FIG. 7 is a back view of another digital camera in accordance with the present invention showing the display in the user viewable position;

FIG. 8 is a bottom view of the camera shown in FIG. 7;

FIG. 9 is a back view similar to FIG. 7 but showing the display in its storage position;

FIG. 10 is a bottom view of the camera shown in FIG. 7 with the display in its storage position; and

FIG. 11 is a side view of an optical system used in digital cameras in accordance with this invention.

In FIG. 1, a block diagram is shown of various systems within the camera 1. As shown, a subject S is positioned in front of the imaging lens 3. The camera includes an area image sensor 20 arranged to coincide with the axis of the imaging lens 3. A printer 30 will be discussed later. An image of the subject is focused on the area image sensor 20. Area image sensor 20 can be a full frame charge coupled device (CCD) or, alternatively, can be an interline device with, for example, photodiode pixels which are adapted to deliver charge to interline CCDs. Conventional electronic circuitry (not shown) is associated with the image sensor 20. After the image sensor 20 receives light representative of the image of the subject S, the circuitry sets up, acquires, and transfers electronic signals from the area image sensor 20. Such electronics are well known in the art and their description is omitted for clarity of discussion.

Logic and control unit 32 causes the area image sensor 20 to transfer electrical signal processor 34. The signal processor will be understood to include that circuitry necessary for converting the area image sensor signals to electrical signals and includes gain control and analog-to-digital circuitry as well known in the art. The logic and control unit 32 can, of course, include a microprocessor as is well known to those skilled in the art. The signal processor 34 delivers, under the control of logic and control unit 32, signals into a storage location in a temporary image memory 35 which can be either a floppy disk or semiconductor memory under the control of logic and control unit 32. These signals, when stored, represent a digital image of the subject. The logic and control unit 32 causes the digital signals in memory to be applied to a display driver 37 which, in turn, applies signals to a display device 38. The display driver 37 will be understood to include a digital-to-analog converter and formatting control which is appropriate for the type of display device as well known in the art. The display device 38 may be embodied as a liquid crystal display. As well understood to those skilled in the art, the logical and control unit 32 provides refresh signals to the display device 38. In accordance with the present invention, when a hard copy is desired, a user signals to logic and control unit 32 to move the display device 38 from a viewing position (shown in dotted lines) to a printing position (shown in solid lines) and to activate the printer as will now be described. It will be understood that the logic and control unit 32 can also deliver the digital image to an external device such as a personal computer.

The logic and control unit 32 is shown to include a central processing unit 32a which may be provided by a microprocessor chip. Execution memory 32b is also shown and is typically provided by random access memory (RAM). This memory is used for computation during image adjustment of the various parameters. As is well known to those in this art, the program memory 32c (typically ROM) can include conventional programs for image rotation, contrast and brightness adjustment, and also changing the color content by so-called color management programs. A user control unit 32d, including a keyboard, permits a user to select the appropriate program by directly inputting interrupt signals into the central processing unit 32a.

Many of such image processing algorithms have been implemented as commercially available packages (which perform all functions on the highest resolution data. See, for example, US-A-5,218,455, the disclosure of which is incorporated herein by reference. These encoding schemes are optimized for performance and are commercially available as libraries of subroutines, such as MathPAK 87 (a trademark of Precision Plus Software). Additional image processing algorithms that may be used are included in the following commercially available packages: Photoshop (trademark of Adobe Systems Incorporated), Color Studio (trademark of Let-

raset), and PhotoMac (trademark of Avalon Development Group). For examples of color management systems including color transforms for changing color content such as contrast, brightness, and gamut, see US-A-5,313,611 and US-A-5,432,906, the disclosures of which are incorporated herein by reference.

Turning now to FIG. 2, the digital camera is shown in a back view. Camera body 1 houses image capture assembly 214. Image capture assembly 214 contains the area image sensor 20 and capture optics 218 (see FIG. 3). Capture optics 218 is adjusted to focus an image onto area image sensor 20. Area image sensor 20 operates to capture an image, which is stored in temporary image memory 35 (see FIG. 1). Captured images are displayed on display device 38, which can be a liquid crystal display of conventional design. Display device 38 is movable from a first viewable position as shown in FIG. 2 to a store/printing position within camera body 1 as shown in FIG. 4. Display device 38 is positioned substantially at the front of the camera body 1 and faces backwards towards a user.

The printer 30 will now be described. Although the printer 30 will be described as a device which is in a fixed position, it will be appreciated that the printer can also be moveable from a storage to a print position and that the display device 38 can also be maintained in a fixed position. In FIG. 3, when display device 38 is moved to the stored position, the image display faces a media cassette 222. Media cassette 222 contains light sensitive media 224. Also, a flat lithium battery 226 is used to provide the power source for both the printer 30 and the camera. The interior of camera body 1 is light tight and permits exposure of the media only upon selective activation of display device 38. To this end, light seals, not shown, are placed around the opening in camera body 1 which receives display device 38. Media cassette 222 is also light tight and has a cassette opening 225, which corresponds to the image capture area of the media. A light-opaque sheet is the first unit of the stack of media 224 and seals the cassette opening 225 before loading. After media cassette 222 is inserted into the camera body 1, the cover sheet is ejected and the printer 30 is ready to print. Media 224 can be provided by conventional instant camera film such as Polaroid Captiva 95 film. Alternatively, media 224 can be coated with microencapsulated crushable color particles such as disclosed in US-A-4,768,050; US-A-5,049,902; and US-A-5,122,432.

Relay optics 221 are disposed between the display device 38 and photosensitive media cassette 222. The relay optics 221 can be formed as an array of micro-optics with a center to center spacing which corresponds to the display element center to center distance (see FIG. 11). In this case the lenslets in the micro-optic array form inverted images of the display pixels, but since they image only one pixel at a time, the inversion has no net negative effect. The lenslets can be formed on the coverglass. If formed on the coverglass, the dis-

play can still be used. Alternately, a 1:1 imaging lens array with lenslet center to center distances much greater than the pixel center to center distance, such as the Ricoh Roof Mirror Lens Array, can be used. In addition, two (or three) arrays can be used to form an inverted image and form a second inverted image of the first image (with an optional array of field lenses if three arrays are used). These multi-array systems can have larger center to center distances than the pixel spacing. In another embodiment, an array of gradient index lenses such as a selfoc lens array from Nippon Sheet Glass can be used. A further embodiment would utilize an array of optical fibers whose diameters are adjusted to be the same as the display pixel center to center spacing to contact print onto a photosensitive media.

Exposure of media 224 is done using display device 38. As display device 38 enters camera body 1, display device 38 is turned off by a sensor being actuated which sends a signal to the central processing unit 32a shown in FIG. 1. When display device 38 is positioned with respect to cassette opening 225, display device 38 is turned on so as to expose media 225. When the user determines that an image is to be printed, the central processing unit 32a retrieves the image from the temporary storage and creates a mirrored image of the previously displayed image and reapplies that to the display device for printing. It will be understood that the program memory 32c includes the necessary program for providing this function. This type of program is well known in the printing art. The display device 38 can be adjusted as well known to those skilled in the art to create an image of correct density and color balance on the media 224.

Upon completion of the exposure of media 224, media 224 is urged into a set of processing rollers 240a and 240b. Motor 238 drives gear train 236 to drive processing rollers 240a and 240b and also to turn a picker cam 234. Timing of the process is done based on the position of picker cam 234. Sensors, not shown, are used to control the operation of motor 238 so as to end each drive cycle in a home position as shown in FIG. 3, a bottom view of the apparatus.

The media 224 is pushed into rollers 240a and 240b by picker 228. Picker 228 operates on the stack of media 224 through picker opening 233 in media cassette 222. Picker 228 is attached through picker arm 230 to picker yoke 232. A compliance structure (not shown) continuously urges picker 228 and picker yoke 232 and picker 228 to the right towards the initial picking position. As picker cam 234 rotates counter clockwise, picker yoke 232 is driven to the left and through picker arm 230 causes picker 228 to push media 224 into processing rollers 240a and 240b. FIGS. 5 and 6 show picker 228 at full travel, with media 224 within the nip formed by processing rollers 240a and 240b.

If media 224 is a conventional instant camera film, processing rollers 240a and 240b burst a packet of processing chemistry. This chemistry is squeezed

across the surface of media 224 as media 224 is driven out of camera body 1. A second chamber (not shown) at the distal end of media 224 receives excess chemistry.

Alternatively, media 224 can be coated with pressure processable chemistry such as microencapsulated crushable color particles. Micro particles or microbeads with dye forming chemistry are coated on the surface of media 224. These beads are responsive to light, so as to polymerize in the presence of actinic radiation. A plurality of polymerizing chemistries is used, responsive to various wavelengths so as to form color images use three dyes nominally forming red, green and blue dyes. Display device 38 provides matching sets of three types of radiation, polymerizing microbeads as a function of wavelength. Processing rollers 240a and 240b are used to selectively burst said microbeads based on the degree of radiation each bead has received. This selective bursting forms a stable color replicate of the image captured by image capture assembly 214.

Motor 238 continues to turn processing rollers 240a and 240b to fully eject media 224. Gear train 236 is designed so that operation of motor 238 will fully eject media 224 before picker cam 232 returns to the starting position. The sensing structure (not shown) senses when picker cam 234 is in the home position and deactivates motor 238.

An alternative embodiment is shown in FIGS. 7 through 10. Where parts correspond to those in the first embodiment, the same numbers will be used. FIG. 7 is a back view which includes display device 38 and image capture assembly 214. These components are operable relative to camera body 1 to move laterally into a deployed position for electronic capture and display of images. Display device 38 and image capture assembly 214 are disposed to the front of the camera body 1. Display device 38 faces toward the back of the camera body 1 so as to be viewable by a user.

FIG. 9 shows the second embodiment in a stored/printing position. The assembly includes a display device 38 and image capture assembly 214 which slides into the camera body 1 in a light-tight fashion. Display device 38 has been brought into a position relative to cassette opening 225 and relay optics 221 so that an image on display device 38 projected onto media 224. Transfer and processing of media 224 occurs in the same manner as the first embodiment. Because of the additional extension of display device 38 and image capture assembly 214, motor 238 has been moved to the back of camera body 1. In addition picker 228 has been lowered slightly to be within the light tight walls formed in camera body 1.

Parts List

1	camera main body
3	imaging lens
20	area image sensor
26	printed circuit board

30 printer
 32 logic and control unit
 32a central processing unit
 32b execution memory
 32c program memory
 32d user control unit
 34 signal processor
 35 temporary image memory
 37 display driver
 38 display device
 214 image capture assembly
 218 capture optics
 221 relay optics
 222 media cassette
 224 media
 225 cassette opening
 226 flat lithium battery
 228 picker
 230 picker arm
 232 picker yoke
 233 picker opening
 234 picker cam
 236 gear train
 238 motor
 240a processing rollers
 240b processing rollers

Claims

1. In an electronic camera, the improvement comprising:
 - a) means for focusing an image of a subject at an image plane;
 - b) area image sensor means disposed at the image plane for receiving the image subject and producing a digital image representing the subject;
 - c) storage means coupled to the area image sensor for storing the digital image of the subject;
 - d) display means responsive to the digital image for displaying an image of the subject;
 - f) image adjustment means initiated by a user after viewing the displayed image for varying parameters of the digital image to provide an improved digital image which is displayed by the display means;
 - g) printer means being effective, in an operative condition, to be optically coupled to the display means for producing a hard copy of the improved subject display image produced by the display means; and
 - h) logic and control means for selectively focusing an image of a subject on the area image sensor and for selectively causing the printer means to be effective in its operative position to make a hard copy representation of the dis-

played subject.

2. In an electronic camera, the improvement comprising:
 - a) means for focusing an image of a subject at an image plane;
 - b) area image sensor means disposed at the image plane for receiving the image subject and producing a digital image representing the subject;
 - c) storage means coupled to the area image sensor for storing the digital image of the subject;
 - d) image processing means for adjusting parameters of the digital image;
 - e) display means responsive to the digital image after its parameter adjustment for displaying an image of the subject; and
 - f) image adjustment means initiated by a user after viewing the displayed image for varying parameters to provide an adjusted image of the subject;
 - g) printer means being effective, in an operative condition, to be optically coupled to the display means for producing a hard copy of the improved subject display image produced by the display means; and
 - h) logic and control means for selectively focusing an image of a subject on the area image sensor and for selectively causing the printer means to be effective in its operative position to make a hard copy representation of the adjusted image.
3. The electronic camera of claim 1 wherein the image adjustment means varies image cropping, image rotation, and image color adjustment.
4. The electronic camera of claim 3 wherein the image color adjustments include varying brightness, contrast, and color content.
5. In an electronic camera, the improvement comprising:
 - a) means for focusing an image of a subject at an image plane;
 - b) area image sensor means disposed at the image plane for receiving the image subject and producing a digital image representing the subject;
 - c) storage means coupled to the area image sensor for storing the digital image of the subject;
 - d) image processing means for adjusting parameters of the digital image;
 - e) display means moveable between a storage

position to a position where it is responsive to the digital image after its parameter adjustment for displaying an image of the subject; and

f) image adjustment means initiated by a user after viewing the displayed image for varying parameters to provide an adjusted image of the subject;

g) printer means being effective, in a operative condition, to be optically coupled to the display means when in the storage position for producing a hard copy of the improved subject display image produced by the display means; and

h) logic and control means for selectively focusing an image of a subject on the area image sensor and for selectively causing the printer means to be effective in its operative position to make a hard copy representation of the adjusted image

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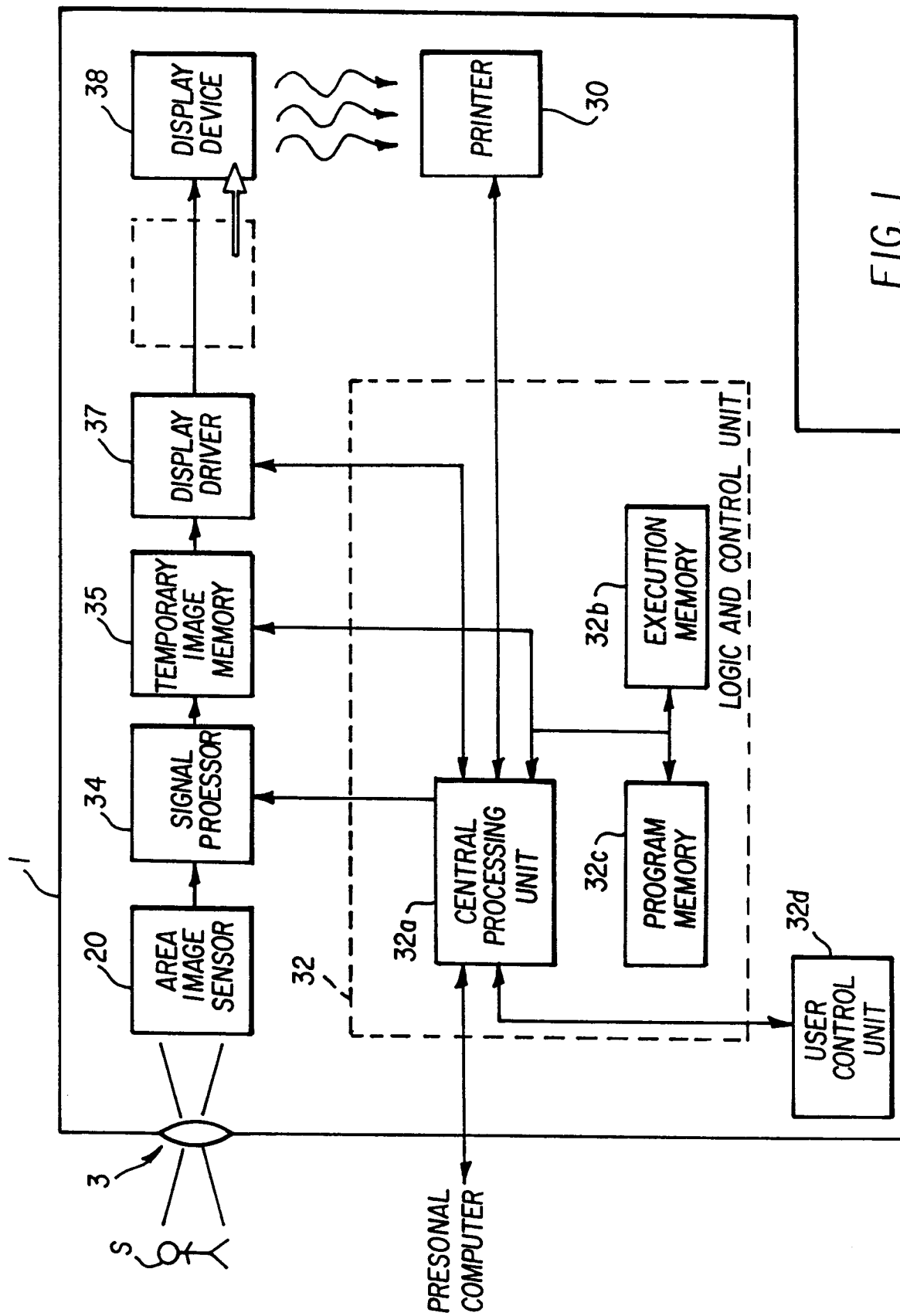
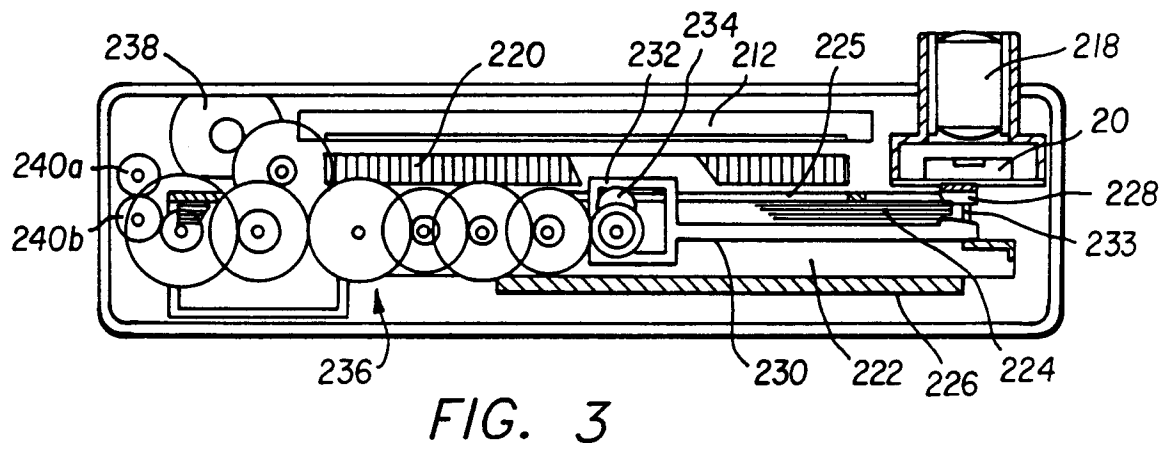
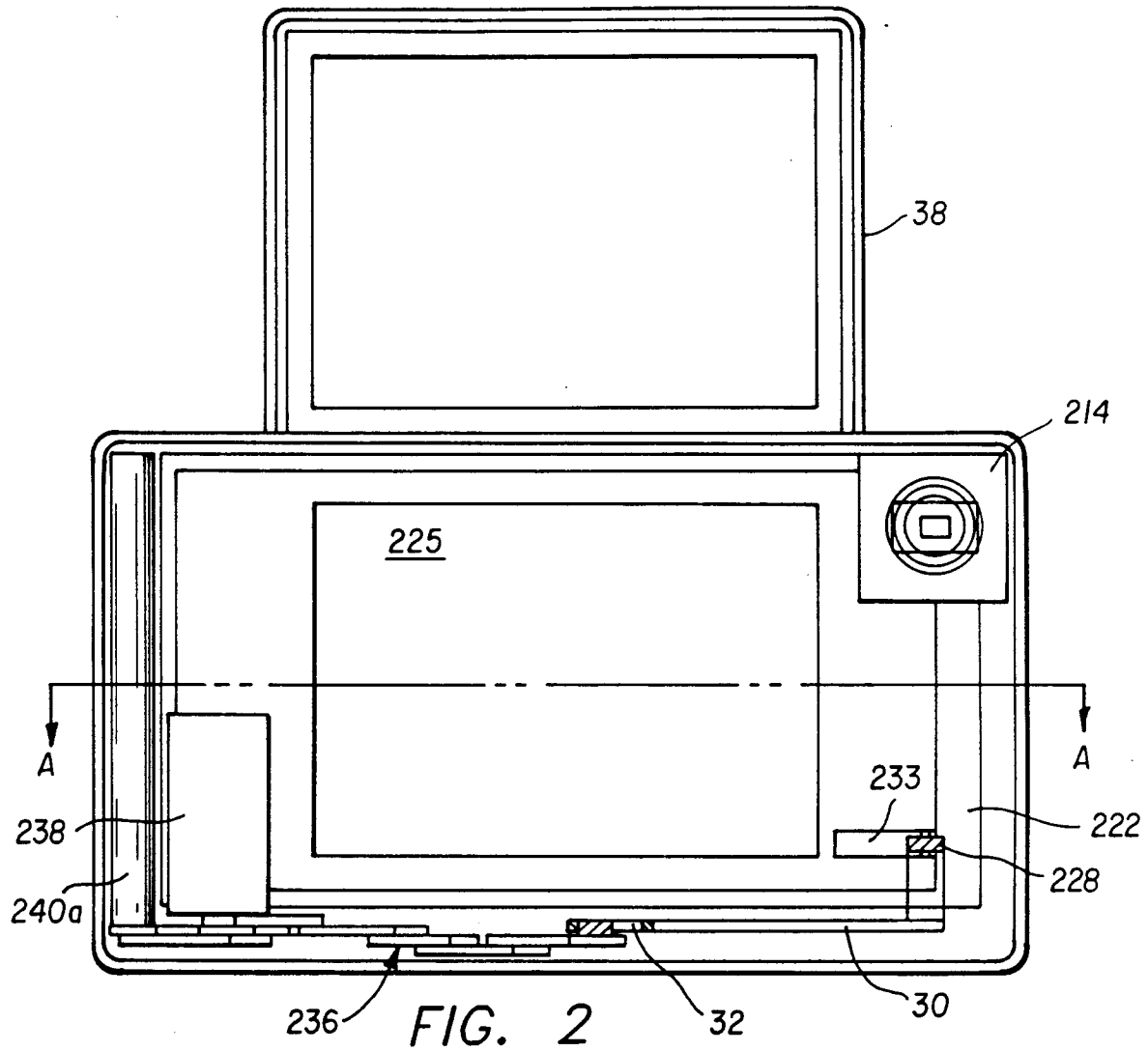
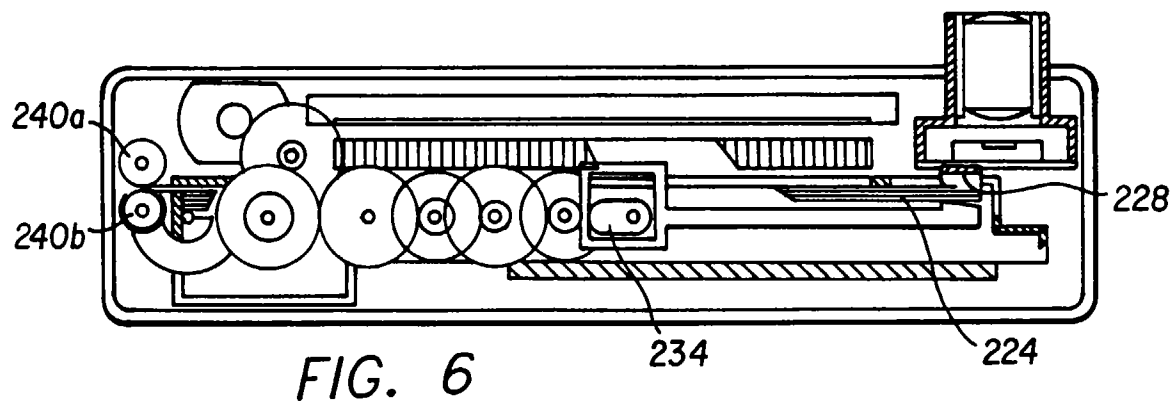
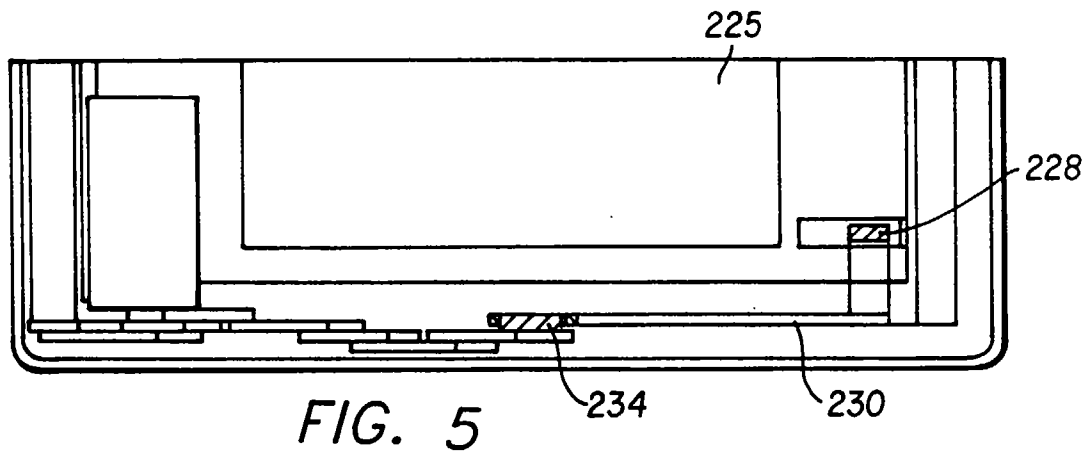
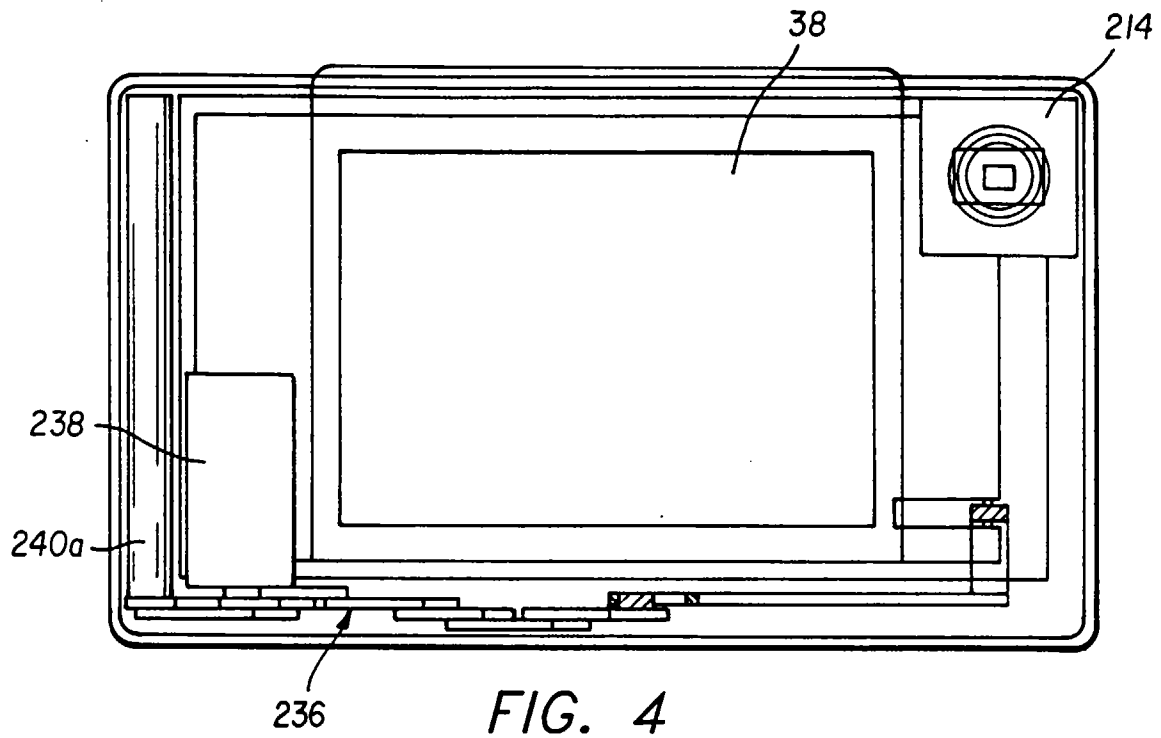


FIG. 1





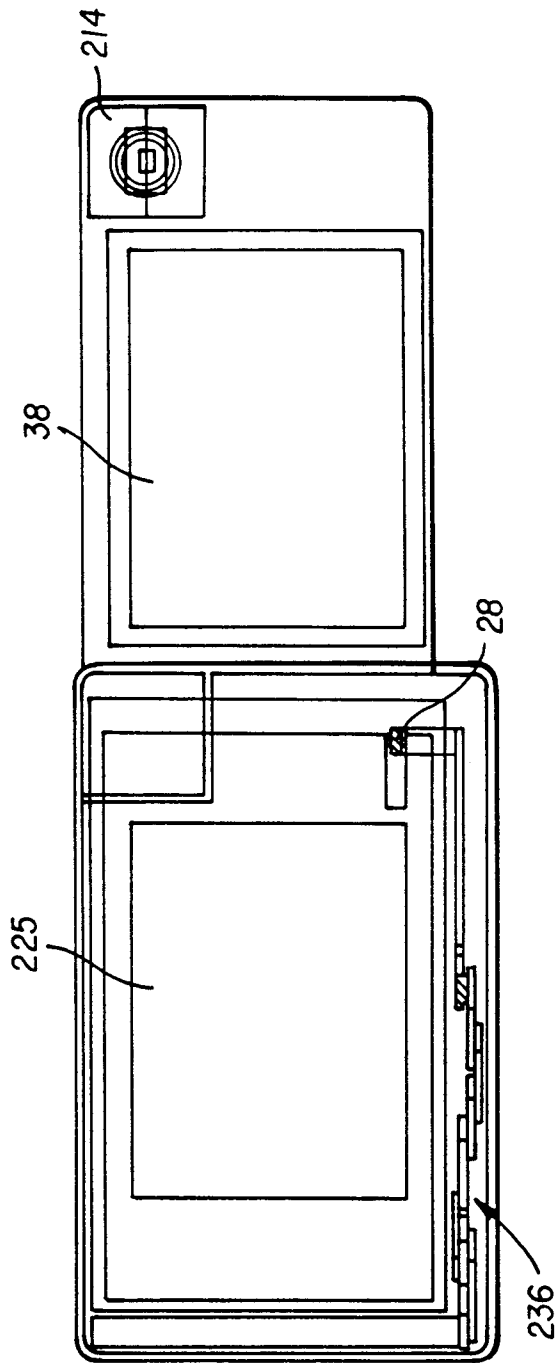


FIG. 7

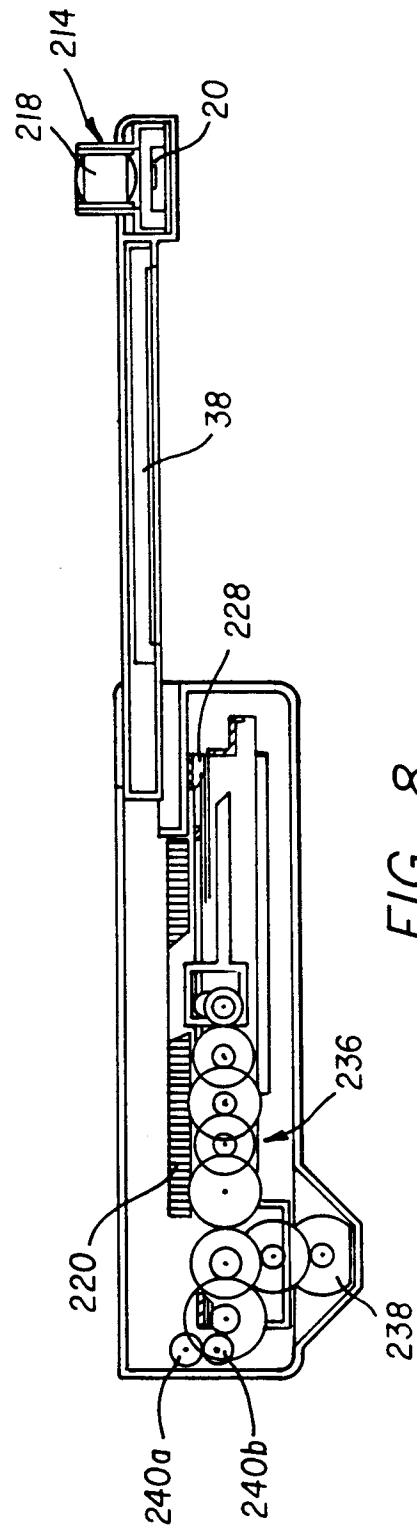
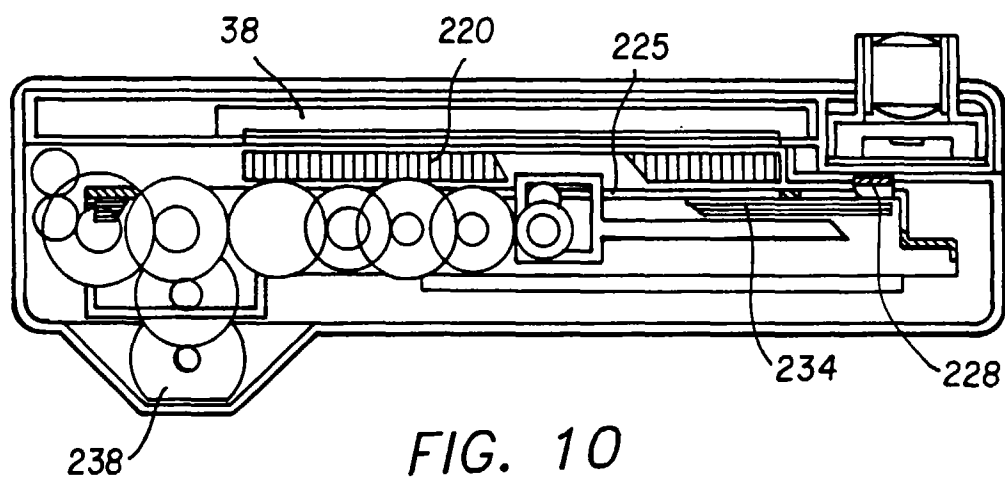
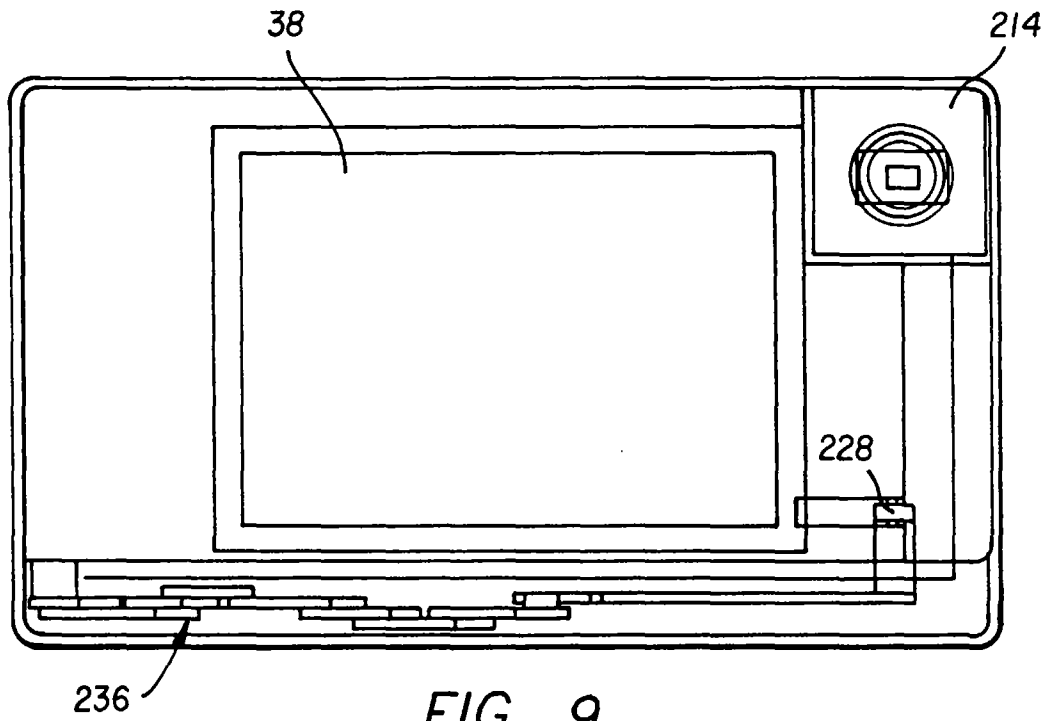


FIG. 8



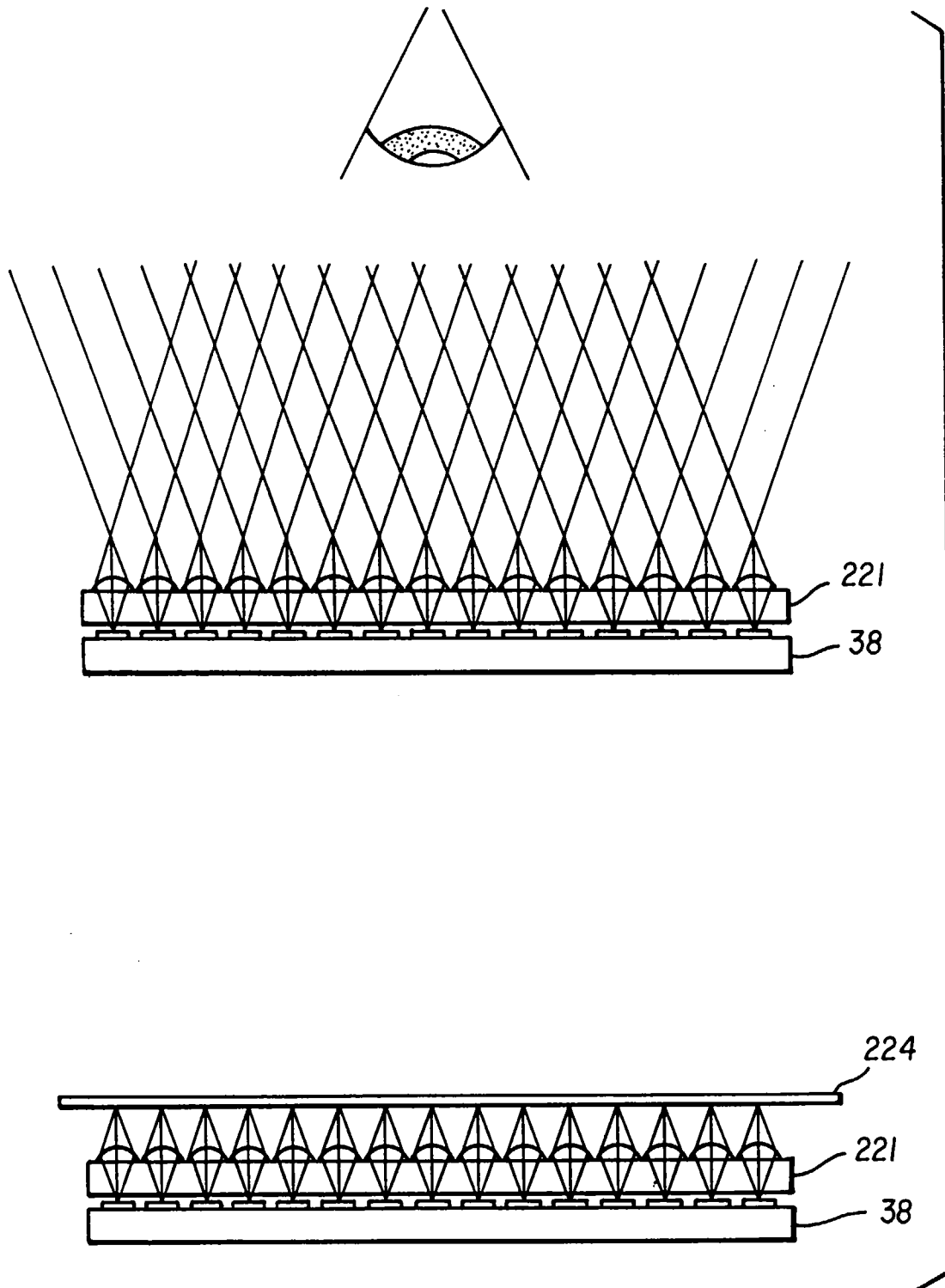


FIG. II